

The El Niño/Southern Oscillation and Future Soybean Prices

Sir - Recently, it was shown that the application of a method combining singular spectrum analysis¹ (SSA) and the maximum entropy method to univariate indicators of the coupled ocean-atmosphere El Niño/Southern Oscillation (ENSO) phenomenon can be helpful in determining whether an El Niño (EN) or La Niña (LN) event will occur^{2,3}. SSA - a variant of principal component analysis applied in the time domain - filters out variability unrelated to ENSO and separates the quasi-biennial (QB), two-to-three year variability, from a lower-frequency (LF) four-to-six year EN-LN cycle; the total variance associated with ENSO combines the QB and LF modes⁴.

ENSO has been known to affect weather conditions over much of the globe⁵. For example, EN events have been connected with unusually rainy weather over the Central and Western US, while the opposite phases of the oscillation (LN) have been plausibly associated with extreme dry conditions over much of the same geographical area⁶.

ENSO's role in determining interannual variations of Earth's climate suggests that it may have important socio-economic repercussions as well. For example, the prices of some agricultural commodities seem to reflect the influence of the climatic oscillation. The solid line in Fig. 1 shows a normalized detrended time series of monthly averaged closing prices of nearest month soybean future contracts traded on the Chicago Mercantile Exchange. Maximas and minimas of the four-to-five year oscillation exhibited by the data appear to match those of the SSA-filtered Southern Oscillation Index (SOI) represented by the dotted line. The SOI is an univariate indicator of ENSO computed from normalized sea-level pressure (SLP) data at Tahiti and Darwin, Australia. The normalization applied to the SLP time series consists in subtracting the time mean from each set of monthly values and dividing the remainder by the standard deviation for the corresponding month. This is the same kind of normalization that was applied to the soybean data.

Multichannel SSA^{7,8} (MSSA) is a multivariate variant of SSA useful in separating anharmonic oscillations from a noisy background. When it is applied to the normalized monthly soybean, Darwin SLP (with its sign reversed), and Tahiti SLP data, after pre-filtering by SSA, the method isolates the QB and LF ENSO components from the three time series. Fig. 2 shows the sum of these two components for each series. The ENSO component of the soybean data (solid) is nearly in phase with that of the two SLP series (dashed and dotted), and the variations of all three MSSA-filtered signals closely match those of the SSA-filtered SOI (Fig. 1: dotted). If the monthly soybean data is replaced by a first order autoregressive process of identical variance, and the entire procedure is repeated, the random signal's MSSA-filtered component (Fig. 3: solid) does not reproduce the behavior of the SSA-filtered

SOI, and the filtered components of the two SLP time series (Fig. 3: dashed and dotted) are corrupted, indicating that the surprising match noticed in Fig. 2 is not the consequence of a numerical artifact.

The MSSA filtered ENSO component of the soybean data captures 18.7% of the variance of the unfiltered data, 10.9% of which is carried by the LF mode and with the remaining 7.4% captured by the QB mode. For comparison, the SSA-filtered SOI (Fig. 1: dotted) captures 21.7% of its unfiltered variance. A cross-correlation analysis shows that the soybean's QB component leads those of the Darwin and Tahiti SLP by two months, and that its LF component leads the corresponding SLP components by seven and four month, for Darwin and Tahiti respectively. Overall, the soybean data's ENSO component leads its Darwin counterpart by four months and the corresponding Tahiti time series by three months, with respective correlations as high as 0.898 and 0.912 being exhibited at those lags. Its maximum correlation with the SSA-filtered SOI (Fig. 1: dotted) is 0.907, at a lead of three months. Incidentally, good three-month-lead ENSO forecasts have been available for a little more than a decade. Since longer-lead forecasts have recently been obtained^{2,3,9}, the soybean's lead over ENSO could soon increase in proportion to the performance of the new forecasts.

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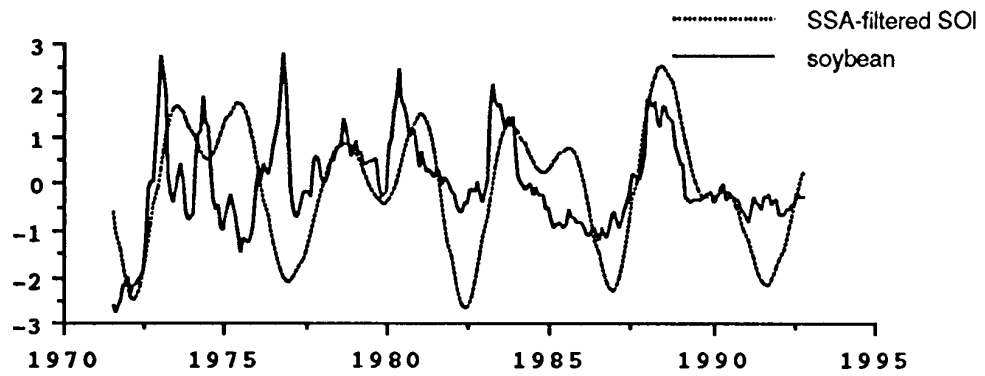


Fig. 1

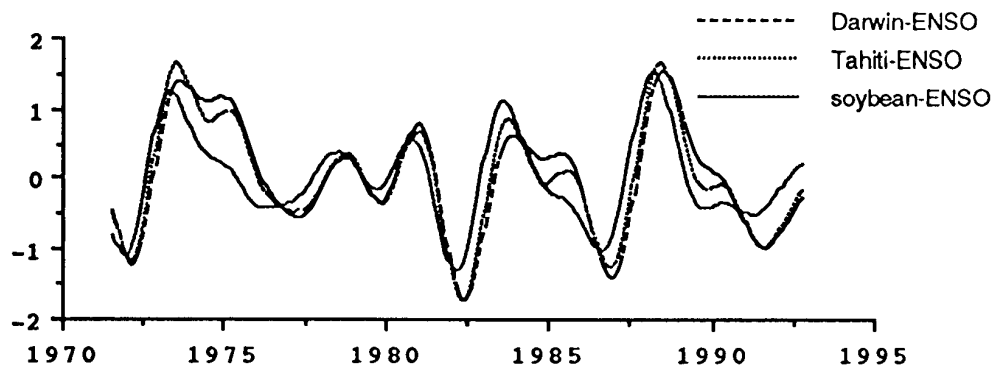


Fig. 2

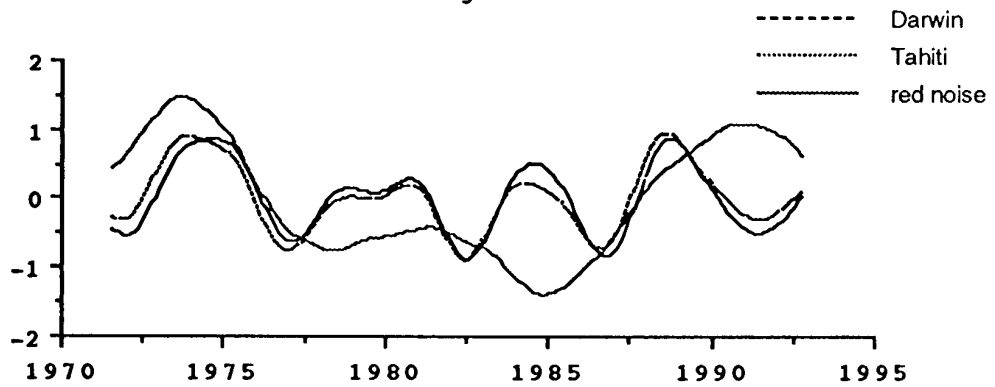


Fig. 3